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GROUND STRESSES AT THE ELDRICH-FLAVEL MINE, QUEBEC

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MICROMEDIA

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B. Arjang*

ABSTRACT

Overcoring strain recovery measurements were conducted at the Eldrich-Flavel Mine in western Quebec. Pre-mining ground stresses were determined at depths of 115 m and 276 m below surface.

The maximum and minimum horizontal compressive stresses are oriented in east-west and northerly directions, respectively. Average gradients for the vertical stress of 0.028 MPa/m, a maximum horizontal stress of 0.084 MPa/m, and a minimum horizontal stress of 0.048 MPa/m were determined.

The horizontal stress perpendicular to the ore zones is about 3.0 times, and on-strike the ore zones 1.7 times the vertical stress.

Key words: Strain recovery measurements; Pre-mining stress.

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CONTRAINTES DU TERRAIN À LA MINE ELDRICH-FLAVEL (QUÉBEC)

par

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RÉSUMÉ

On a effectué des mesures de recupération de la déformation causé par le surcarottage à la mine Eldrich-Flavel dans l'Ouest québécois. Les contraintes du sol avant exploitation ont été mesurées sous la surface à des profondeurs de 115m et 276m.

Les déformations horizontales maximales et minimales dues à la compression sont orientées dans les directions est-ouest et nord, respectivement. On a déterminé les gradients moyens pour la contrainte verticale à 0,028 MPa/m, à 0,084 MPa/m pour la contrainte horizontale maximale et à 0,048 MPa/m pour la contrainte horizontale minimale.

La contrainte horizontale perpendiculaire aux zones minéralisées est environ 3,0 fois la contrainte verticale, et dans la direction des zones minéralisées 1,7 fois la contrainte verticale.

Mots-clés : Mesure de récupération des contraintes, contrainte pré-exploitation.

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INTRODUCTION

Pre-mining ground stresses were determined at the Eldrich-Flavel Mine, Evain, Quebec, for the purpose of stability evaluations. The stress determination was requested in the context of a preliminary geomechanical assessment of the mine carried out by CANMET (1).

GEOLOGICAL SETTING AND MINING BACKGROUND

The Eldrich-Flavel Mine is situated about 20 km west of Rouyn-Noranda, near Evain, Quebec. The location of the mine within the Abitibi orogenic belt is shown in Figure 1.

The host rocks at the mine are tonalite and diorite, which are portions of the Flavian pluton, the largest regional intrusive. The finely disseminated gold mineralization is concentrated along a sub-vertical strike-slip fault, the Eldrich Wrench Fault (2). The ore zones occur in a series of small lenses, oriented in a northerly direction and dipping 35^{o} to 45^{o} towards east.

Dominant structural features are the Eldrich Wrench Fault with the associated shear zones and the planar sub-vertical and sub-horizontal joint sets.

The projected mine plan in the western section is to expand the open stopes to surface crown pillar dimensions. Most mining activities, however, will take place in the east portion of the mine with open stopes with 24 m spans on-strike and dipping at about 40^{o}s.

At present the deepest working level is about 300 m below surface. The mining of deeper levels to a depth of about 650 m is planned.

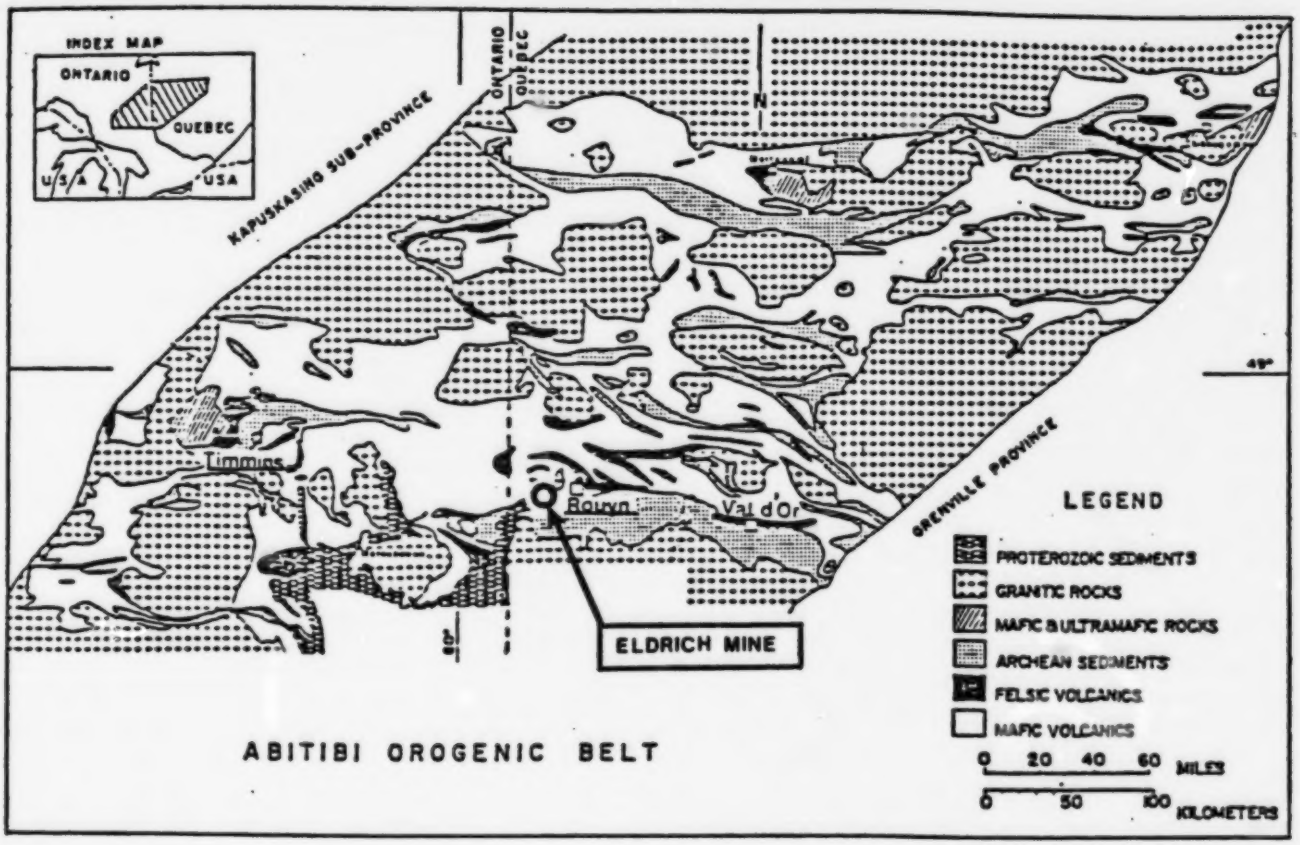

Fig. 1 - Regional geology (1), and location of the Eldrich Mine.

STRESS MEASUREMENT SITES

The stress determination sites were selected 115 m (level 2) and 276 m (level 6) below surface, as shown in Figure 2. The horizontal test holes were drilled nearly perpendicular to the main structural trend. Overcoring measurements using CSIR triaxial strain cells were taken in a fine-medium grained tonalite (quartz-diorite) at locations greater than 5 m from the excavation boundary.

The test hole on level 2 was located about 15 m from the strike-slip fault in the hanging wall. No major discontinuities were exposed in the proximity of the stress measurement site on level 6.

At test locations, competent and high strength rocks made drilling as well as the core recovery difficult (a mean uniaxial compressive strength of 235 MPa was determined on EX-core specimens from the test holes).

In addition, sub-horizontal joints intersected in the test holes resulted in core breakage. Four tests out of eight overcoring measurements attempted were successful.

RESULTS OF STRESS DETERMINATIONS

The elastic strain recoveries from triaxial strain cell measurements are given in Table 1. An average strain invariance of 23 microstrains was obtained for the four tests conducted.

Table 2 provides the results of stress determinations. The stress components in horizontal directions, and the direction of principal stresses, are related to the mine coordinate system (Grid north = Geographic north). The orientation of the principal compressive stresses and the main trend of the ore zones are illustrated in Figure 3.

For the stress tensor calculations, an elastic modulus of 70 GPa and

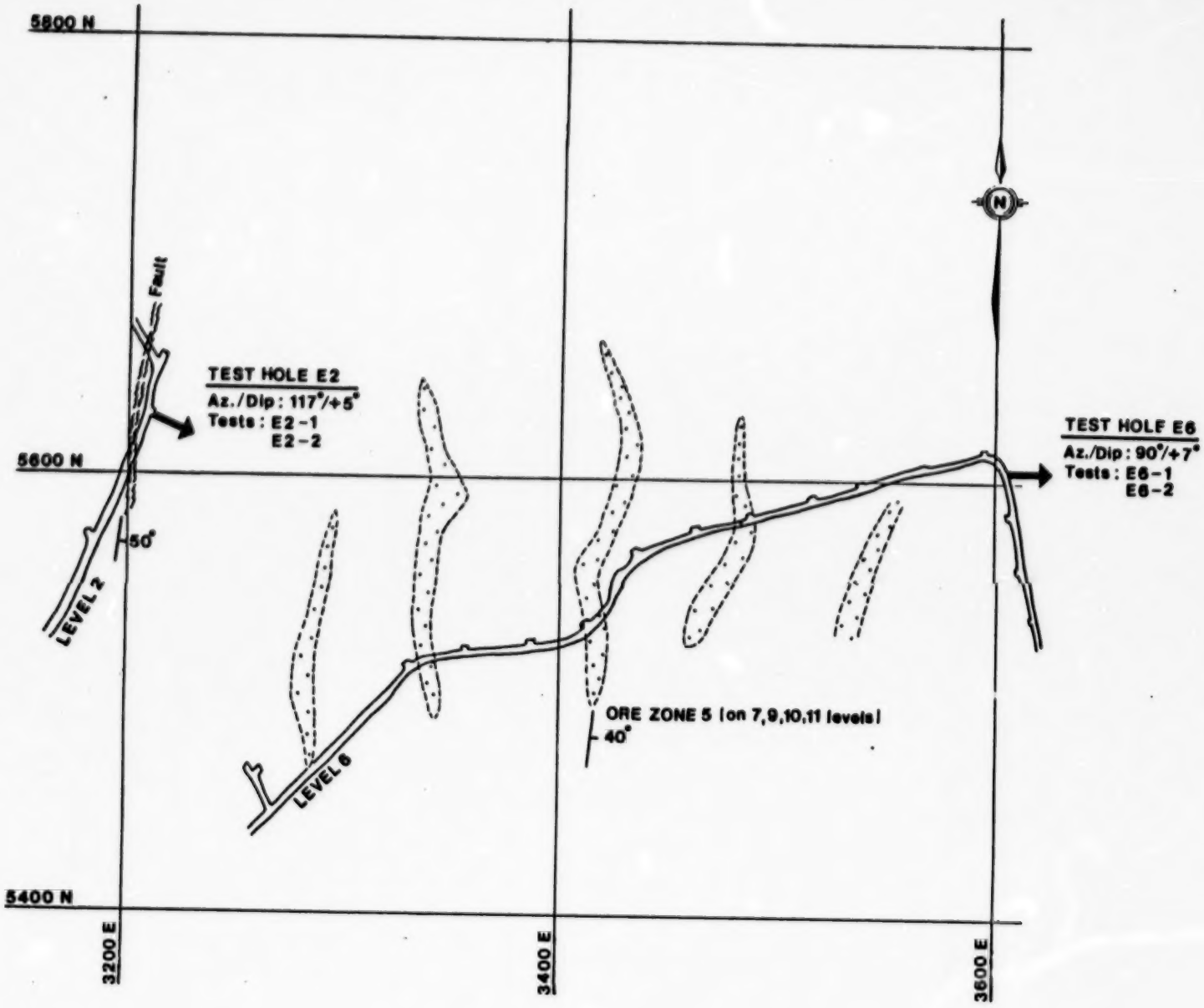

Fig. 2 - Stress determination sites and test hole locations on levels 2 and 6. The plan shows a projection of the ore zones/mine level intersections (not to scale).

Table 1 - Strain recovery from triaxial strain cell measurements.

Location	Test No.	Test Depth (m)	Gauge No.: Elastic Strain Recovery ($x10^{-6}$)												SI (*) Rosette No.		
			1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
Level 2	E2-1	5.35	10	80	120	60	5	50	100	40	340	65	85	370	10	15	10
(115 m)	E2-2	5.80	60	65	70	30	95	145	165	85	175	155	95	120	35	30	5
Level 6	E6-1	4.90	70	165	305	205	165	285	180	70	225	415	305	85	5	10	30
(276 m)	E6-2	6.85	40	120	250	180	30	80	150	65	480	105	205	535	50	35	45

(*) Strain invariance (sum of strain in two orthogonal directions, $\varepsilon_1 + \varepsilon_3 = \varepsilon_2 + \varepsilon_4$).

Table 2 - Stress components and principal compressive stresses from field stress determinations.

Location	Test No.	Stress Components (MPa) (Standard errors in brackets) σ_{EW}	σ_{NS}	σ_v	τ_{EN}	τ_{NV}	τ_{VE}	StDv	Principal Compressive Stresses (MPa) σ_1	σ_2	σ_3
Level 2 (115 m)	E2-1	11.4 (1.6)	5.2 (1.0)	3.1 (1.0)	0.60 (0.5)	-2.5 (0.7)	-2.4 (0.7)	0.33	12.3 079/18*	6.3 340/26	1.2 200/58
	E2-2	8.9 (1.4)	6.4 (0.8)	3.5 (0.8)	-1.2 (0.6)	-0.9 (0.6)	0.25 (0.5)	0.27	9.4 294/06	6.1 025/15	3.3 184/74
Level 6 (276 m)	E6-1	20.6 (3.3)	9.0 (2.0)	7.4 (2.0)	-0.80 (1.5)	-1.0 (1.5)	4.66 (1.2)	0.66	22.2 275/18	9.0 009/11	5.7 129/69
	E6-2	17.4) (3.0)	10.2 (1.8)	5.8 (1.8)	4.1 (1.4)	-4.4 (1.4)	0.02 (1.0)	0.60	19.6 062/08	11.1 326/35	2.7 164/54

* Orientation of principal compressive stresses: Bearing/dip in degrees in the mine coordinate system (Grid north = Geographic north).

Note: Stress calculations are based on: Elastic modulus = 70 GPa, Poisson's ratio = 0.23.

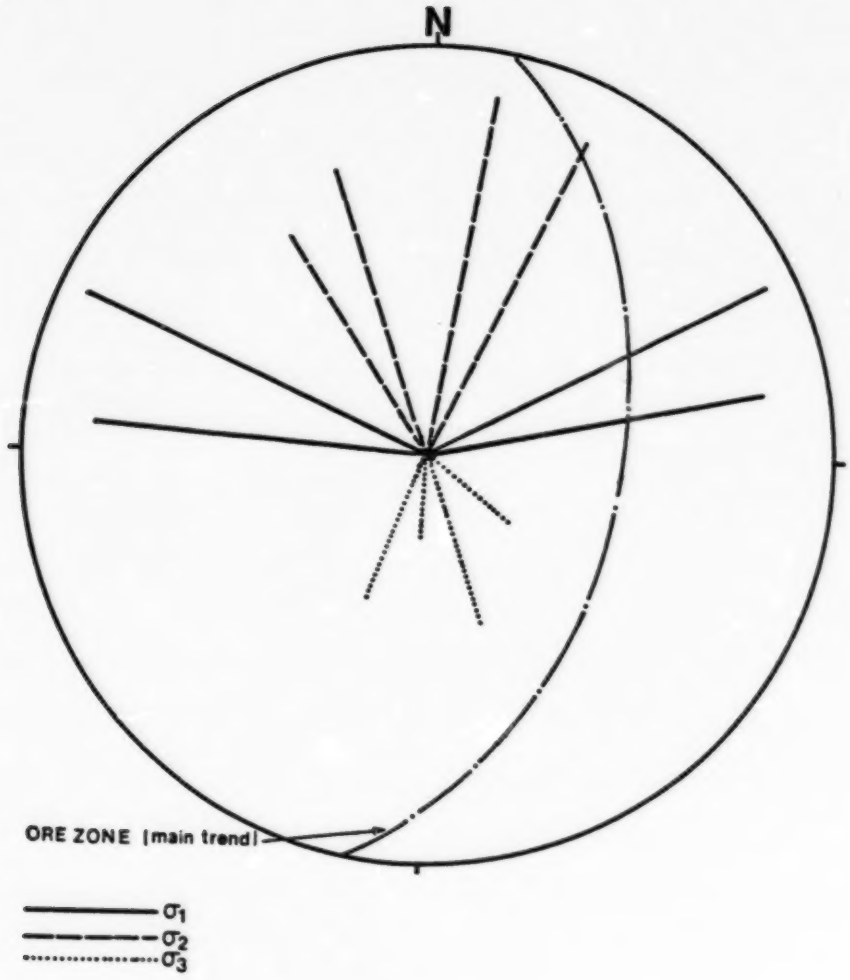

Fig. 3 - Orientation of the principal compressive stresses from Grid north (= Geographic north) in an equal area net, lower hemisphere projection.

Poisson's ratio of 0.23 were used. These mean values were obtained from the uniaxial compressive tests conducted on NQ-size cores of tonalite (4).

The results from stress determinations indicate insignificant differences in the stress magnitudes at the individual test sites. Comparing both measurement sites, a close agreement exists between the orientation of the maximum and the intermediate principal compressive stresses. The maximum and intermediate principal compressive stresses are oriented nearly horizontal, prevailing in east-west and northerly directions, respectively. The minor principal compressive stress is oriented nearly vertical.

Based on limited data, the average gradients are, for the vertical stress, 0.028 MPa/m, for the maximum horizontal stress, 0.084 MPa/m, and for the minimum horizontal stress, 0.048 MPa/m. The stress gradients are comparable with the data obtained at similar depths from the mines in northern Ontario and western Quebec.

The results of stress determinations on level 2, which was located in the proximity of the major strike-slip fault, did not indicate anomalous field stress. An average horizontal stress gradient of 0.074 MPa/m was determined, compared to 0.073 MPa/m on level 6. However, distortion of the stress field can be expected on the fault contact (hanging wall/footwall), where extensive shear zones parallel to the fault plane and significant changes in the rock properties occur.

With regard to the orientation of ore zones (~N 15^{o}E/40^{o}E), the maximum horizontal stress acts perpendicular while the minimum horizontal stress is parallel to the ore zones. The ratios of measured maximum to minimum horizontal stress (σHmax, σHmin) and the horizontal stresses to vertical stress (σv) were as follows:

Level	σHmax/σHmin	σHmax/σv	σHmin/σv
2	1.6-2.0	2.7-3.0	1.7-2.0
6	1.6-2.2	2.8-3.6	1.6-1.7

The stress ratios indicate a wide range of variation. For the application of numerical modelling, however, the pre-mining vertical stress as well as the horizontal stres es perpendicular and parallel to the ore zones can best be approximated as follows:

Vertical stress, σv : 0.028 MN/m^3 x depth (m) in MPa

Horizontal stress, perpendicular : 3.0 x σv

Horizontal stress, parallel : 1.7 x σv

The above relationships apply for the stability evaluations at the present stage of mining. For the projected depth of 650 m, however, application of these values should be exercised with caution.

ACKNOWLEDGEMENTS

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